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Report on Lake Meredith Hutchinson, Moore, and Potter Counties, Texas

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

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Report
on
Lake Meredith
Hutchinson, Moore, and Potter Counties
Texas
EPA Region VI
Working Paper No. 653

With the cooperation of the
Texas Water Quality Board
and the
Texas National Guard
March, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

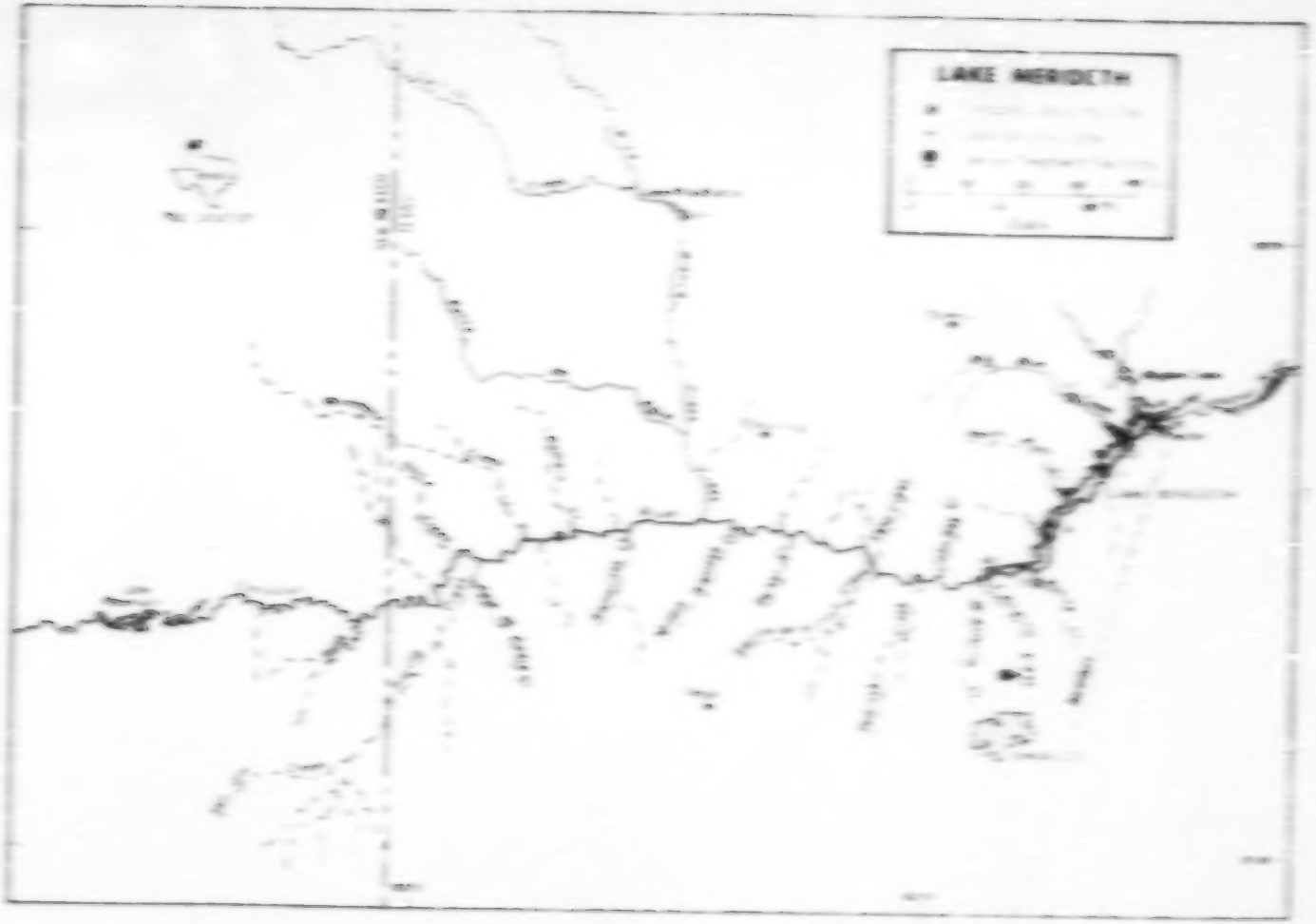
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


LAKE MERIDETH

LAKE MEREDITH

STORET NO. 4823

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Meredith is mesotrophic; i.e., moderately supplied with nutrients and moderately productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the reservoir. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Lake Meredith ranked second in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six water quality parameters*. Seven of the water bodies had less median total phosphorus, eleven had less and six had the same median dissolved orthophosphorus, two had less and three had the same median inorganic nitrogen, two had less mean chlorophyll a, and 11 had greater mean Secchi disc transparency. Marked depression of metalimnetic dissolved oxygen occurred at stations 1 and 2 during the August sampling.

Survey limnologists did not observe macrophytes or surface algal concentrations during sampling visits. In a report on a previous study on Lake Meredith, it is noted that aquatic vegetation is not a problem (Krsal, 1974).

* See Appendix A.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the times the samples were taken. The lake data indicate nitrogen limitation at all sampling stations in March and October, at station 4 in May, and at stations 1 and 2 in August.

C. Nutrient Controllability:

1. Point sources--The only known point source impacting Lake Meredith during the sampling year was the wastewater treatment plant at Amarillo which accounted for an estimated 28.9% of the total phosphorus load.

The present phosphorus loading of 6.41 g/m^2/year is nearly 23 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 14). However, the lake primarily is nitrogen limited, and this may account for the rather low chlorophyll a levels and the absence of aquatic vegetation problems.

The median inorganic nitrogen concentration in the lake was only 70 µg/l, and it is questionable whether point-source phosphorus control would result in a shift to persistent phosphorus limitation.

2. Non-point sources--During the sampling year, non-point sources contributed 71.1% of the total phosphorus load. The Canadian River contributed 70.8% and three other gaged tributaries collectively contributed less than 1%. The ungaged minor tributaries and immediate drainage were estimated to have contributed less than 1%.

The phosphorus export rate of the Canadian River was much higher than the other tributaries in this drainage basin (see page 12). This may be the result of underestimation of the point-source load contributed by the Amarillo wastewater treatment plant.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 66.77 kilometers².

2. Mean depth: 16.0 meters.

3. Maximum depth: =26.2 meters.

4. Volume: 1,066.229 x 10⁶ m³.

5. Mean hydraulic retention time: 8.6 years.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km²)†††	Mean flow (m³/sec)†††
Canadian River	39,823.8	6.290
Bonita Creek	166.8	0.057
Big Blue Creek	666.6	0.253
Hughes Creek	19.7	0.005
Minor tributaries & immediate drainage -	821.6	0.279
Totals	41,497.5	6.884

2. Outlet -

Aqueduct		2.778*
Canadian River	41,564.3	1.170
Total	41,564.3**	3.948

C. Precipitation***:

1. Year of sampling: 58.6 centimeters.

2. Mean annual: 51.5 centimeters.

† Table of metric conversions--Appendix B.
†† At conservation pool level; Williams, 1976.
††† For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
* Anonymous, 1975.
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Meredith was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at four stations on the lake (see map, page vi). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 26.2 meters at station 1, 21.9 meters at station 2, 14.0 meters at station 3, and 9.1 meters at station 4.

The sampling results are presented in full in Appendix D and are summarized in the following table.

[illegible] SUMMARY OF [illegible] CHEMICAL AND [illegible] CHARACTERISTICS FOR [illegible]
[illegible] [illegible]

PARAMETER	1ST SAMPLING (JULY 1978) - SITES			2ND SAMPLING (SEPTEMBER 1978) - SITES			3RD SAMPLING (OCTOBER 1978) - SITES		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	5.0 - 7.0	6.1	5.0	16.0 - 18.7	17.7	17.5	25.7 - 26.7	25.8	25.8
DISS O2 (MG/L)	9.7 - 10.6	10.2	10.1	7.0 - 9.1	7.7	7.8	5.1 - 7.1	5.1	5.0
CNDCTVY (MICROMHO)	1125. - 1288.	1241.	1238.	1420. - 1599.	1525.	1515.	1751. - 2000.	1855.	1854.
PH (STAND UNITS)	8.1 - 8.5	8.4	8.4	8.1 - 8.4	8.3	8.3	7.1 - 8.0	7.7	7.7
TOT ALK (MG/L)	145. - 288.	194.	190.	145. - 142.	288.	248.	145. - 178.	188.	180
TOT P (MG/L)	0.804 - 0.837	0.815	0.814	0.823 - 0.844	0.837	0.829	0.814 - 0.824	0.818	0.817
ORTHO P (MG/L)	0.800 - 0.825	0.811	0.809	0.834 - 0.913	0.887	0.887	0.802 - 0.819	0.811	0.809
NO2+NO3 (MG/L)	0.825 - 0.855	0.837	0.836	0.818 - 0.844	0.829	0.829	0.818 - 0.845	0.829	0.829
AMMONIA (MG/L)	0.823 - 0.842	0.832	0.830	0.842 - 0.858	0.851	0.850	0.850 - 0.858	0.857	0.856
KJEL N (MG/L)	0.384 - 0.787	0.458	0.455	0.788 - 0.885	0.835	0.829	0.828 - 0.883	0.851	0.851
ORGN N (MG/L)	0.840 - 0.850	0.847	0.846	0.817 - 0.838	0.829	0.828	0.840 - 0.846	0.842	0.841
TOTAL N (MG/L)	0.346 - 0.738	0.485	0.481	0.878 - 0.988	0.864	0.856	0.845 - 0.788	0.851	0.851
CHLOPHYL A (UG/L)	0.7 - 1.4	1.2	1.2	0.2 - 4.8	2.8	2.1	0.2 - 4.1	0.7	1.4
SECCHI (METERS)	1.5 - 3.1	2.2	2.1	0.4 - 2.2	1.3	1.3	1.1 - 2.4	1.8	1.7

[illegible]

[illegible] SAMPLING LOCATION

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

B. Biological characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Algal Units per ml
03/05/74	1. Chroomonas sp.	734
	2. Oocystis sp.	341
	3. Flagellates	262
	4. Cryptomonas sp.	105
	5. Stephanodiscus sp.	52
	Other genera	105
	Total	1,599
05/14/74	1. Oocystis sp.	801
	2. Nitzschia sp.	615
	3. Binuclearia sp.	476
	4. Chroomonas sp.	450
	5. Stephanodiscus sp.	316
	Other genera	530
	Total	3,188
08/07/74	1. Chroomonas sp.	286
	2. Cryptomonas sp.	82
	3. Coelastrum sp.	41
	4. Microcystis sp.	20
	5. Oocystis sp.	20
	Other genera	62
	Total	511

* The October phytoplankton sample was lost in shipment.

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
03/05/74	1	0.7
	2	1.0
	3	1.4
	4	1.9
05/14/74	1	1.5
	2	1.9
	3	2.7
	4	6.0
08/07/74	1	2.4
	2	0.2
	3	4.3
	4	4.0
10/28/74	1	3.2
	2	3.8
	3	4.6
	4	9.7

C. Limiting Nutrient Study:

The algal assay results are not considered representative of conditions in the lake at the times the samples were collected (03/05/74 and 10/28/74) due to significant changes in nitrogen and phosphorus in the samples during shipment from the field to the laboratory.

The lake data indicate nitrogen was limiting in March and October. However, at the other two sampling times, a combination of limiting nutrients is indicated. Following is a tabulation of

the mean inorganic nitrogen/orthophosphorus ratios for each of the sampling stations and times with the indicated limiting nutrient in parentheses.

Station	03/05/74	05/04/74	08/07/74	10/28/74
1	8/1 (N)	20/1 (P)	9/1 (N)	4/1 (N)
2	8/1 (N)	16/1 (P)	8/1 (N)	4/1 (N)
3	7/1 (N)	18/1 (P)	29/1 (P)	3/1 (N)
4	5/1 (N)	12/1 (N)	32/1 (P)	5/1 (N)

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of May when two samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries, including the aqueduct, were calculated using mean annual concentrations and mean annual flows. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Big Blue Creek at station F-1 and the mean annual ZZ flow.

The operator of the Amarillo wastewater treatment plant did not participate. Therefore, nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year, and flows were estimated at 0.3785 m^3/capita/day.

A. Waste Sources:

1. Known municipal* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Amarillo - North	109,000	act. sludge	41,256.5	East Creek

2. Industrial - Unknown

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Canadian River	302,870	70.8
Bonita Creek	35	<0.1
Big Blue Creek	130	<0.1
Bugbee Creek	5	<0.1
b. Minor tributaries & immediate drainage (non-point load) -	140	<0.1
c. Known municipal STP's -		
Amarillo	123,605	28.9
d. Septic tanks - None	-	-
e. Industrial - Unknown	?	-
f. Direct precipitation** -	1,170	0.3
Total	427,955	100.0

2. Outputs -

Lake outlet -	Aqueduct	1,400
	Canadian River	480
	Total	1,880

3. Net annual P accumulation - 426,075 kg.

* Wyatt, 1976.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Canadian River	1,175,510	77.2
Bonita Creek	1,070	<0.1
Big Blue Creek	4,560	0.3
Bugbee Creek	115	<0.1
b. Minor tributaries & immediate drainage (non-point load) -	5,025	0.3
c. Known municipal STP's -		
Amarillo	370,710	22.8
d. Septic tanks - None	-	-
e. Industrial - Unknown	?	-
f. Direct precipitation* -	72,085	4.4
Total	1,629,070	100.0

2. Outputs -

Lake outlet -	Aqueduct	56,070
	Canadian River	19,115
	Total	75,185

3. Net annual N accumulation - 1,553,885 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Canadian River	8	30
Bonita Creek	<1	6
Big Blue Creek	<1	7
Bugbee Creek	<1	6

* See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	6.41	6.38	24.4	23.3

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Meredith:

"Dangerous" (eutrophic loading)	0.28
"Permissible" (oligotrophic loading)	0.14

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA T[illegible] HE [illegible] I[illegible]

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INCR[illegible]	SED- [illegible] REC	[illegible] CHLOR[illegible]	I[illegible] [illegible]	[illegible] [illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE

[illegible] DATA TO BE USED IN [illegible]

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG P	SED [illegible] SED	[illegible] CHLPHA	[illegible] MIN ZO	[illegible] DISS [illegible]
[illegible]	SOMERVILLE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	STAMFORD LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	STILLHOUSE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TEMPLE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TEXOMA LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	TRINIDAD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TWIN BUTTES RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WHITE ROCK RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WHITNEY LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] OF LAKES WITH VOLUMES VALUES [illegible] NUMBER OF LAKES WITH VOLUMES VALUES

LAKE CODE	LAKE NAME	VOLUME TOTAL P	VOLUME INSTAN A	VOLUME MEAN SEC	VOLUME CYCLONE	VOLUME [illegible]	VOLUME [illegible]	[illegible] NU
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible] CITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] CHRISTI LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	EAGLE [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	FT [illegible] HILL LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GARZA LITTLE ELM RESERVO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE OF THE PINES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LEXINGTON LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LYNDON B JOHNSON LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PALESTINE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] KINGDOM [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN ANGELO [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	E O SPENCE RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PERCENT OF LAKES WITH HIGHER VALUES; NUMBER OF LAKES WITH HIGHER VALUES

LAKE CODE	LAKE NAME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	29 % (113)	55 % (221)	24 % (96)	3 % (13)	87 % (350)	38 % (150)	404
[illegible]	[illegible]	18 % (70)	47 % (177)	5 % (20)	18 % (70)	82 % (310)	39 % (146)	254
[illegible]	[illegible]	69 % (335)	37 % (180)	67 % (325)	42 % (204)	17 % (81)	51 % (248)	492
[illegible]	[illegible]	32 % (125)	78 % (304)	37 % (144)	21 % (80)	62 % (241)	38 % (148)	253
[illegible]	[illegible]	13 % (49)	51 % (198)	13 % (50)	26 % (99)	72 % (279)	13 % (50)	176
[illegible]	[illegible]	39 % (240)	36 % (139)	61 % (239)	46 % (179)	17 % (65)	79 % (306)	417
[illegible]	[illegible]	68 % (329)	22 % (86)	62 % (354)	62 % (333)	17 % (81)	84 % (327)	484
[illegible]	[illegible]	8 % (30)	46 % (180)	11 % (40)	5 % (20)	92 % (358)	8 % (30)	388
[illegible]	[illegible]	59 % (230)	21 % (80)	58 % (225)	60 % (233)	40 % (155)	63 % (245)	391
[illegible]	[illegible]	84 % (329)	41 % (159)	76 % (296)	89 % (346)	17 % (65)	63 % (245)	348
[illegible]	[illegible]	63 % (244)	51 % (198)	76 % (295)	71 % (277)	17 % (66)	76 % (295)	357

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	239
30	[illegible]	[illegible]	217
31	[illegible]	[illegible]	200
32	[illegible]	[illegible]	200
33	[illegible]	[illegible]	176
34	[illegible]	[illegible]	173
35	[illegible]	[illegible]	169
36	[illegible]	[illegible]	159
37	[illegible]	[illegible]	155
38	[illegible]	[illegible]	139
39	[illegible]	[illegible]	91

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]

[illegible]						
[illegible]						
[illegible]						
[illegible]						

[illegible]

[illegible]
[illegible]
[illegible]

[illegible]
[illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	00065 GAGE HEIGHT FEET	32217 CHLOROPHYLL A UG/L	00631 INCL NO2 & NO3 NITROGEN PERCENT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]			[illegible]
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]		

[illegible] [illegible]

[illegible]
35 30 [illegible] [illegible] [illegible]
[illegible]
[illegible]

[illegible]
3

[illegible]
[illegible] FEET [illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		TEMP		SECCHI	FIELD			DAILY	TOTAL	N	[illegible]
TO	DAY	FEET	CENT	[illegible]	[illegible]	[illegible]	SU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	16	20	[illegible]	6.2			48	1150	6.68	198	8.836	8.722	8.836	8.689
	16	30	[illegible]	6.2	16.4			1136	6.66	149	8.838	8.488	8.946	8.812
	16	20	[illegible]	6.1	18.2			1150	6.68	198	8.838	8.488	8.839	8.889
	16	30	[illegible]	5.6	16.4			1150	6.66	196	8.846	8.488	8.838	8.818
	16	30	[illegible]	5.6	16.2			1148	6.66	197	8.846	8.588	8.858	8.836
[illegible]	15	30	[illegible]	16.7			22	1586	6.36	198	8.846	8.488	8.871	8.886
	15	30	[illegible]	17.6	6.8			1539	6.36	192	8.849	8.386	8.898	8.889
	15	30	[illegible]	17.4	7.6			1536	6.38	191	8.849	8.296	8.898	8.888
	15	30	[illegible]	17.3	7.8			1533	6.48	191	8.842	8.368	8.873	8.889
[illegible]	14	45	[illegible]	24.7	6.6		58	1694	7.88	185	8.846	8.688	8.828	8.8828
	14	45	[illegible]	24.5	6.8			1668	7.72	186	8.838	8.488	8.828	8.8828
	14	45	[illegible]	24.1	5.4			1669	7.78	196	8.856	8.388	8.846	8.883
	14	45	[illegible]	23.9	5.8			1657	7.66	188	8.[illegible]	8.488	8.886	8.867
[illegible]	04	35	[illegible]	18.4	8.8		28	1537	8.44	177	8.836	8.788	8.8289	8.813
	04	35	[illegible]	18.4	8.2			1536	8.46	177	8.8284	8.488	8.8284	8.813
	04	35	[illegible]	18.4	8.8			1536	8.46	176	8.828	8.588	8.8284	8.812
	04	35	[illegible]	18.3	8.8			1532	8.46	177	8.828	8.488	8.8284	8.812
	04	35	[illegible]	18.3	8.4			1531	8.48	175	8.828	8.488	8.8284	8.812

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		A	[illegible]
TO	DAY	FEET	[illegible]	[illegible]
[illegible]	16	20	[illegible]	8.812	1.4	
	16	30	[illegible]	8.828		
	16	20	[illegible]	8.816		
	16	30	[illegible]	8.816		
	16	30	[illegible]	8.813		
[illegible]	15	30	[illegible]	8.829	7.7	
	15	30	[illegible]	8.816		
	15	30	[illegible]	8.834		
	15	30	[illegible]	8.833		
[illegible]	14	45	[illegible]	8.832	4.3	
	14	45	[illegible]	8.828		
	14	45	[illegible]	8.823		
	14	45	[illegible]	8.856		
[illegible]	04	35	[illegible]	8.825	4.6	
	04	35	[illegible]	8.828		
	04	35	[illegible]			2.4
	04	35	[illegible]	8.821		
	04	35	[illegible]	8.822		
	04	35	[illegible]	8.824		

[illegible] [illegible]
[illegible] [illegible] [illegible]

[illegible] METHODS, DATE 04/07/11

[illegible]
35 33 38.0 103 45 12.0
[illegible]
[illegible] Texas

[illegible]
3

[illegible]
84.24 FEET [illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 pH SU	00410 T ALK CACO3 MG/L	00440 BICARB MG/L	00625 TOT KJEL N MG/L	00628 K,DISSOLVED MG/L	00671 PHOS-DIS DISSOLVED MG/L P
04/13/05	17 10	0000	7.4		40	1241	8.04	288	0.340	0.780	0.630	0.025
	17 10	0005	7.5	10.0		1185	8.06	199	0.420	0.580	0.820	0.011
	17 10	0015	7.4	8.8		1148	8.08	194	0.830	0.580	0.850	0.026
	17 10	0030	7.8	10.0		1288	8.08	195	0.830	0.480	0.830	0.018
04/05/14	15 05	0000	20.3		17	1546	8.35	198	0.890	0.480	0.340	0.011
	15 05	0005	16.8	7.6		1571	8.38	199	0.845	0.380	0.840	0.012
	15 05	0009	17.4	8.0		1561	8.46	199	0.865	0.580	0.870	0.013
04/08/07	15 28	0000	24.8	7.8	50	1894	7.68	185	0.850	0.480	0.830	0.002
	15 28	0005	24.5	7.2		1888	7.48	187	0.840	0.480	0.825	0.002P
	15 28	0015	23.7	6.6		1862	7.48	185	0.857	0.480	0.825	0.003
04/10/28	10 10	0000	14.8	8.6	24	1368	8.53	197	0.830	0.580	0.130	0.029
	10 10	0005	14.9	8.6		1384	8.53	200	0.835	0.480	0.105	0.029
	10 10	0012	14.9	8.2		1391	8.53	195	0.830	0.580	0.130	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	84031 INCBT LT 47 MM/M2 AFDW/DAY
04/13/05	17 10	0000	0.029	1.9	
	17 10	0005	0.023		
	17 10	0015	0.037		
	17 10	0030	0.021		
04/05/14	15 05	0000	0.040	4.9	
	15 05	0005	0.035		
	15 05	0009	0.044		
04/08/07	15 28	0000	0.021	2.0	
	15 28	0005	0.022		
	15 28	0027	0.042		
04/10/28	10 10	0000	0.094	6.7	
	10 10	0003			1.0
	10 10	0005	0.043		
	10 10	0012	0.071		

* VALUE FROM TO BE LESS THAN INDICATED

[illegible]

APPENDIX 5

TRIBUTARY DATA

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	%	TOTAL	[illegible]	
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L P	MG/L P
[illegible]							
74/04/07	11	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74/10/04	10	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74/11/13	15	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74/12/26	15	75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/01/26	11	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/02/15	14	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/03/07	14	45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/04/04			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/05/05	15	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/05/27	04	07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/06/17	10	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/07/04	04	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
75/08/12	14	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]
[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]
[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]
[illegible]

[illegible]

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